

# LESLIE ORGAN SPEAKER

PIPE VOICE OF THE ELECTRIC ORGAN

**MODEL 22H**

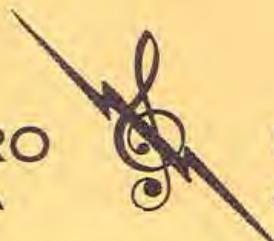
*for the*

HAMMOND  
ORGAN

## OWNER'S MANUAL

INSTRUCTIONS, SERVICE INFORMATION  
AND PARTS LIST

ELECTRO  
PASADENA



MUSIC  
CALIFORNIA

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## UNPACKING AND SHIPPING

When the Leslie Organ Speaker is first unpacked from its original shipping box:

1. Remove the upper and lower compartment back covers.
2. Remove the wood shipping blocks from upper and lower motors and amplifier, so these units float freely on their rubber mounts. Save the wood blocks to reuse if the cabinet is to be shipped at some future time.
3. Make sure the upper belt is in place on the rotor, idler, and motor pulleys.
4. Select the desired tremolo speed on the upper motor pulley. The center groove is the one most often used. Slower or faster speeds are available by use of the other pulley grooves.
5. The compartment covers can now be replaced and the cabinet is ready for use.

For further handling, the cabinet may be moved or carried about without any preparation whatsoever unless it is to be shipped by truck or rail. When this is done, the original shipping block should be placed in the motor and amplifier mountings to prevent damage. The cabinet may be carried by hand in any position.

Transporting the Leslie in a horizontal position carefully over short distances should do no harm, but it should not be subjected to severe jarring such as in a trailer or truck while in that position.

## CONNECTING THE LESLIE SPEAKER TO LARGER SERIES HAMMOND CONSOLES HAVING MORE THAN ONE OCTAVE OF PEDALS

The Leslie speaker connects to these consoles by means of the regular external speaker cable furnished with the console.

Leslie tremulant control equipment consists of a terminal box mounted inside the console, and an on-off tremolo control switch mounted at the keyboard rail in front of the lower manual. Install the tremulant control equipment in the console as follows:

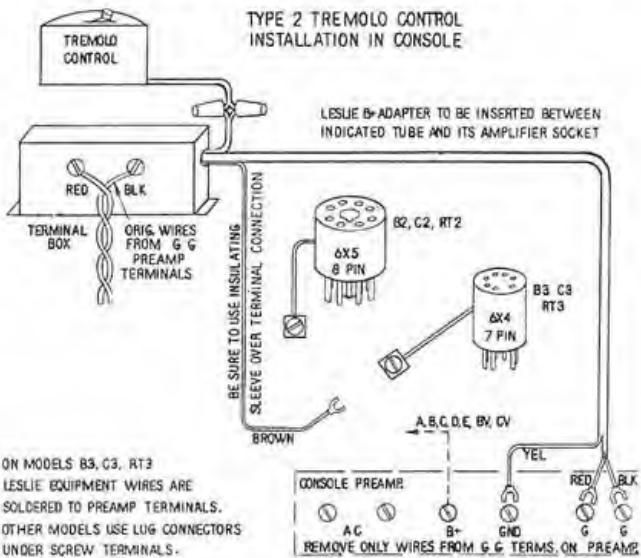
1. Attach the plastic switch case assembly to the wood rail directly in front of lower manual. Most organists prefer the control to be located over to the left and in front of the preset keys.
2. Unbolt and lift the manuals to pass the switch cable into the generator compartment.

An alternate way to obtain the same neat appearance is to push the tremolo control cable through the space under the manuals which is sealed by a felt strip.

Where the manuals underside meets the console kneeboard, a felt dust seal will be found. Near the left end of this seal use a small blade screwdriver to push the felt downward and create an opening to push the switch cable through and into the generator compartment. Then reach in behind the Start motor and pull the cable through.

Another alternate installation method is to run the cable down along the corner formed by the console inner side and the kneeboard, and then underneath to the back. With the back of console removed, cut a small notch in the shelf to allow switch cord entry into the interior.

3. Inside the generator compartment, mount the terminal box convenient to preamplifier and connect the various wires as shown in the following diagram. Attach the switch cord wires to the terminal box by twisting the matching wire ends together and securing with furnished wire nuts.



Connect the console speaker cable to the Leslie speaker.

## Connecting the Leslie Speaker to Hammond Spinet Model Two Manual Consoles (M Series)

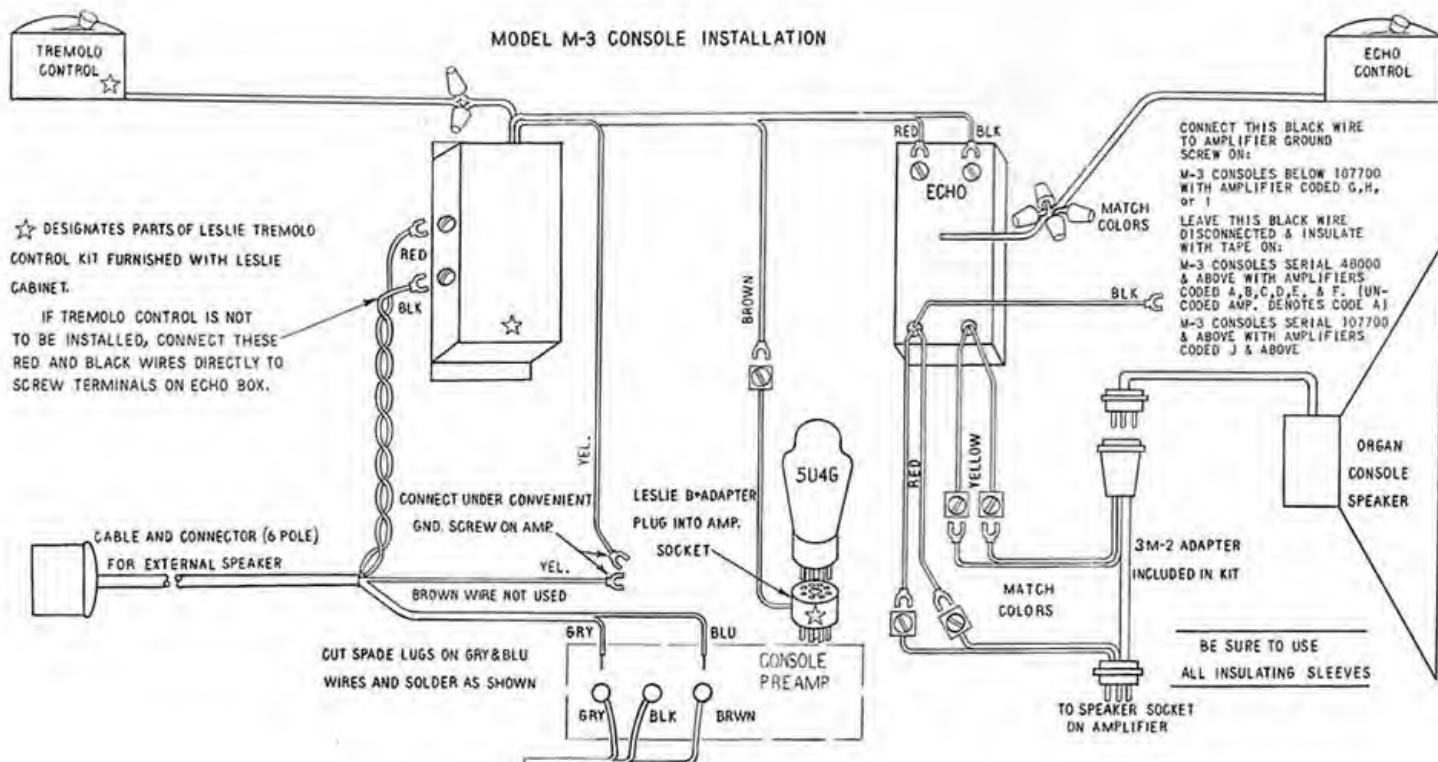
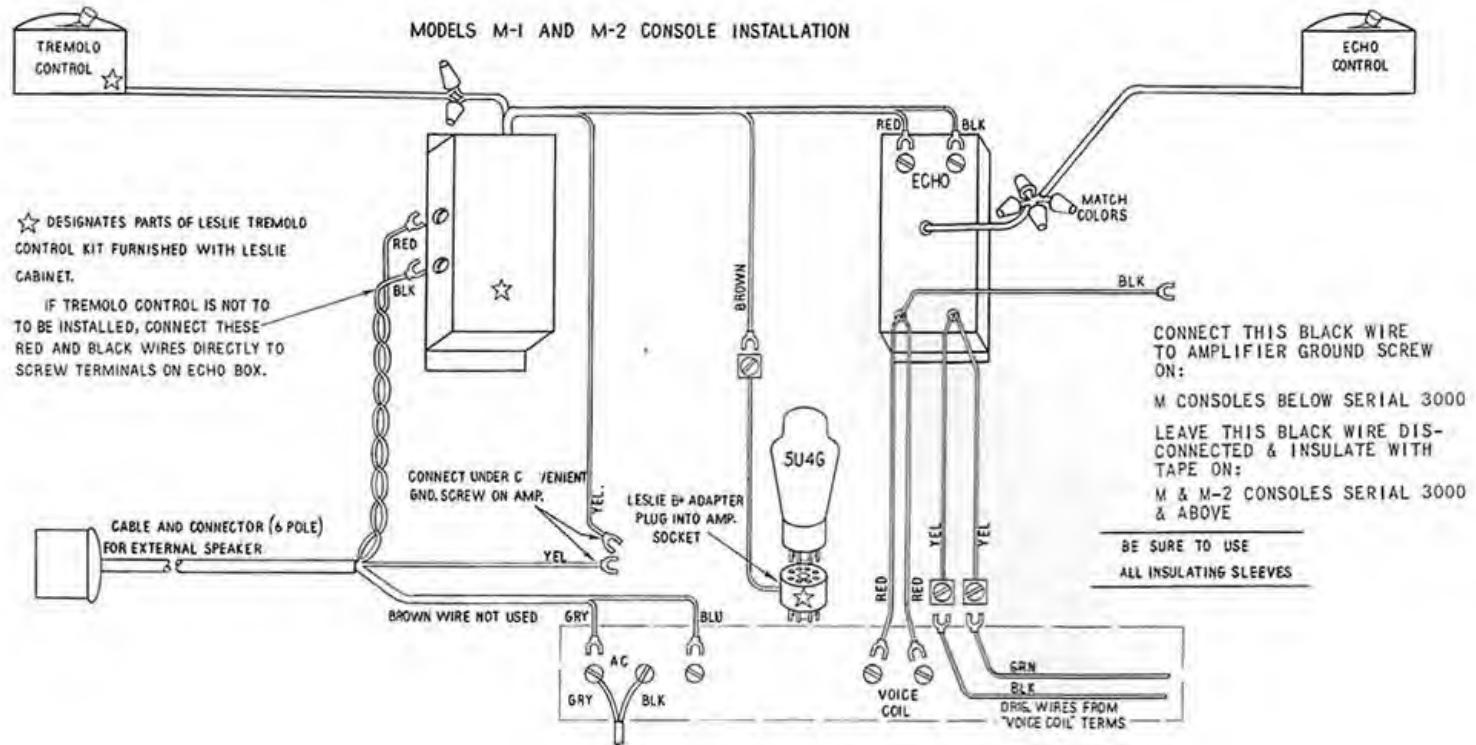
Use of the Leslie with spinet models will require obtaining a speaker connecting cable for the external Leslie.

It is suggested that a Leslie 3-M Echo control Kit be ordered. This provides a completely prepared 30 foot cable, and in addition, all equipment needed to allow the organist to use the Leslie or the console speaker separately, or both in ensemble. Complete wiring information is furnished with each 3-M kit and is also included here. Proceed as follows:

1. Attach the tremolo switch case at the left end, and the Echo switch case at the right end of the keyboard rail. Openings will be found at both ends of the keyboard underside. Pass the switch cables to the generator compartment through these openings.

2. Connect the wiring as follows:

As viewed from the back, secure the external speaker cable at left lower corner of console with the supplied clamp.



## TREMOLO CONTROL ARRANGEMENT

Tremulant control on the Leslie speaker is obtained by turning the power for the driving motors on and off by means of an internal relay in the speaker cabinet amplifier.

There are three tremulant motor power outlets on the Leslie amplifier chassis. The tremolo control installed at the console provides for on-off power control at two outlets simultaneously. These two controlled outlets are also wired as part of the built-in automatic Electric Brake circuit. The third outlet has power "on" at all times when the Leslie is being used. These outlets are identified on the instruction card permanently fastened to the cabinet back. Both tremulant motors are plugged into controlled outlets when the speaker is shipped from the factory.

An arrangement preferred by many organists is to have the lower or bass tremulant driving motor plugged into the always "on" outlet and the treble rotor motor into a controlled outlet. This way the lower rotor runs continually, and the upper rotor only will be turned on and off by the switch at the console.

### Tremolo Rotor Cycling

When the Leslie speaker is first turned on, the rotors plugged into controlled sockets will rotate for approximately 10 secs. and then stop. If the console tremolo switch is "on," the rotors will again start rotating after 10 secs. and continue.

This initial rotor cycling is normal and occurs only during initial tubes warmup time. After warmup, fully normal on-off control will be obtained.

### Additional Speakers

Any number of speakers can be added to the installation. When adding earlier Leslies having serial number below 5200 or Hammond without input grid blocking condensers, include a Type 2 Adapter at each such speaker.

Leslies with serial numbers above 5200 need no Adapters. Refer to Multiple Speaker Instructions in this manual for details.

### VOLUME CONTROL SETTING

Organ signal output level varies from console to console, so the Leslie amplifier has a volume control to allow for correction of these signal level variations, regardless of console model used. The control can also be used to reduce the maximum available loudness for balancing the Leslie sound output with other tone cabinets.

To set this control properly for maximum undistorted loudness, proceed as follows:

1. Turn volume control to least loudness position or to left as far as it will go.
2. Pull all drawbars for pedals and one of the manuals out to position eight. With swell pedal completely open or maximum loudness position, play a pedal note and full chords.

3. Advance volume control on Leslie amplifier until distortion becomes noticeable, and then back off slightly to eliminate all distortion. This is the proper setting for maximum loudness and will need no further adjustment.

4. Do not leave the volume control adjustment at a setting where distortion is continually produced. Prolonged use under such overloaded conditions can cause damage to the speaker units.

If a particular application requires greater loudness than is obtained with proper volume control setting, additional Leslie speakers can be added to increase the output without overload or distortions. See the chapter on Multiple Speaker Use.

The adjustments are now completed and the instrument is ready for use.

## GENERAL PERFORMANCE AND USE INFORMATION

The Leslie Cabinet should rest firmly on the floor. It is not necessary that the cabinet be absolutely level, but any unevenness in the resting surface should be compensated by snug fitting wedges.

### SPECIAL TREMOLO EFFECTS

Separate effects for each manual of the organ can be obtained with the following suggested arrangement. Many organists find this very useful for certain kinds of church or liturgical music.

On the Leslie, the lower rotor driving motor is connected to run continually, and only the upper rotor is to have on-off control by the Leslie tremulant switch.

For one manual, choose a stop with little upper harmonic content—such as the Tibia. Adjust the other manual for a rich, higher harmonic content—such as Strings quality.

With the Leslie tremulant switch in "off" position, the Strings stop manual when played an octave or higher above Middle C, will have a smooth character with negligible tremolo. But the Tibia stop manual, when played in the Middle C range will have a normal tremolo. It now becomes evident that at the organist's discretion, either accompaniment or solo parts can be played against straight or Leslie tremulant effect.

When the Leslie is used with consoles containing an electronic vibrato attachment, a particularly valuable combination is obtained with the arrangement suggested above, plus the console vibrato knob on "No. 1" position.

Consoles with separate vibrato control for each manual when used with the Leslie, make possible many interesting combinations of acoustical tremolo and electronic vibrato. For example with the Leslie lower rotor running continually and the upper rotor turned off, add Electronic Vibrato to the manual on which the range an octave or more above Middle C will be played. The other manual played around Middle C will have the acoustic tremolo from the Leslie.

Because of basic differences in vibrato generation, the two treatments provide a good contrast.

The user is urged to consider and become familiar with these various possibilities for adapting to personal style and taste for even more interesting musical results.

When using Leslie tremulants, the use of chorus and tremulant controls in early model consoles should be avoided as they tend to produce choppy and unmusical effects.

On series 3 consoles equipped with percussion type device, the Leslie speaker makes possible many interesting combinations. The organ does not provide for a tremolo on percussion sounds. The Leslie tremulant will provide a tremolo for such percussive sounds as Vibraharp.

For percussion effects that are desirable without tremolo, the Leslie tremulant can be turned off. This versatility obtained in one speaker system is always under full control by the organist.

#### Broadcasting and Recording with the Leslie

To obtain full rich pipe-organ effects, the organ should be played at fairly high sound volume using a live studio. The microphone should be placed about ten to fifteen feet away from the speaker. For a smooth tremolo, adjust microphone height so that it is either above or below the upper speaker louvres in the cabinet.

#### Non-Organ Use of the Leslie

The Leslie speaker when used as intended, will provide performance unmatched by that obtainable with "High Fidelity" apparatus. This organ speaker system incorporates many design features to enhance or improve musical characteristics of the Electric Organ. The design approach required to achieve this result is totally different in acoustical and electrical properties from what is needed in other applications. This specialized concept is what makes the Leslie unique, but restricts recommended use to electric organs.

Of course the Leslie can be made to work as an amplifier for a phonograph, other electronic instruments, or a public address system. But the likelihood of lasting satisfaction with the results is not great. Bearing the previous considerations in mind, it will be understood why electrical or other laboratory measurements made on the Leslie have only academic value, and for comparison with other equipment are irrelevant.

### RECOMMENDED PERIODIC MAINTENANCE

A few precautionary periodic maintenance checks will greatly extend the time of pleasurable and trouble free operation.

#### Cabinet Polishing

The finish on the Leslie Cabinet is the same as used on the rest of your fine household furniture. Treat it accordingly, and use the same kind of furniture polish whenever indicated.

#### Six Month Intervals (Oiling)

1. Oil the tremulant motors by placing 20 or 30 drops of the furnished high grade oil or sewing machine oil in each of the two oil tubes at the back of the cabinet.
2. Inspect the amplifier and make certain all tubes are lit. It is important that all tubes in the amplifier be functioning.
3. Inspect the tremulant driving belts for unexpected fraying.

#### One Year Intervals

In addition to the six month checks, the upper tremulant rotor should be oiled at this time. The oil hole is found at the center of the bakelite tremulant assembly, and is clearly marked. Place about five drops of the furnished oil in the marked hole. Allow the oil to drop slowly so it will flow down rather than overflow at the opening. Take particular care to keep oil from getting onto pulley grooves or driving belt.  
NOTE: On instruments in constant commercial use, the motors should be oiled every three months, and the upper rotor every six months.

#### Amplifier Tubes

To maintain constant satisfactory performance, it is suggested that a completely new set of tubes be installed after about a thousand use hours are completed. The degradation of tubes with long use is so gradual that one may not be aware that sub-standard results are being obtained. The new tubes, if carefully checked, will restore original vitality to your Leslie system. Bear in mind that new tubes can be faulty and may require testing before being put in service.

**INSTRUCTIONS FOR  
MULTIPLE LESLIE SPEAKER INSTALLATIONS  
AND COMBINATIONS OF HAMMOND AND LESLIE SPEAKERS**

**USE OF: 3H Echo Control**

**Type 2 Adapter**

**5A Relay**

Results obtained from the use of one Leslie are usually quite satisfactory, but a surprising amount of added grandeur and fullness can be achieved from the use of two or more units. One speaker might be compared to a pipe organ with one chest of pipes, whereas adding Leslies tends to create the effect of additional chests of pipes. Even though more power is not always desired, two speakers are often employed for the extra musical characteristics. For best results, multiple speakers should be separated by at least fifteen or twenty feet, and different tremulant speeds for each speaker (by belt adjustment) can be chosen so as to get the intermingling tremolo effects so characteristic of large pipe organs.

There is no problem using any Hammond speaker along with Leslie. However, opinions differ on desirability of Hammond reverberation signal being passed on to the Leslies. Circuits including the reverberation effect in the Leslie speakers can present installation difficulties which must be worked out individually. It is beyond the scope of this booklet to deal with such possibilities.

#### **Leslie Speaker Serial Numbers**

31 series cabinets were made in earlier and later models. Earlier Leslies are those with serial numbers below 5200. All later model Leslies for Hammond organs have serial numbers above 5200. This includes most 31 series, and all 21H and 22H series speakers.

For installation considerations, the fundamental difference is in Leslie tremulant on-off control circuits. Needed equipment and instructions are furnished with each Leslie, and installation is planned to be simple.

#### **Connecting Cables**

Later model Leslie speaker cabinets will obtain on-off tremolo control with either five or six conductor cables from the console. So regardless of the Hammond console model, for console to first Leslie connection, the original furnished console cable plugs into the Leslie amplifier, and fully controlled operation is obtained.

#### **Tremulant Control**

Tremulant on-off control in earlier Leslies is obtained by a controlling current being carried over the sixth or B+ wire in the connecting cable.

Later Leslies are designed for tremulant control operation with the improved Type 2 tremolo control system, and are furnished with this equipment. The new system, instead of needing a separate wire for

control, superimposes a DC controlling voltage on the signal line to all amplifiers in the chain.

Only one tremolo control switch is needed at the console to provide simultaneous on-off control of all Leslies in a multiple system.

Amplifiers in the later Leslie series have internal provision to use the superimposed DC signal line voltage for control purposes, and to isolate it from the input grids.

Amplifiers in earlier Leslies and all Hammond tone cabinets do not use this voltage, and also don't have isolation provision.

#### **CONTROL VOLTAGE ISOLATION WITH TYPE 2 ADAPTER**

In a multiple speaker system including a type 2 tremolo control circuit, earlier Leslies with serial below 5200, and Hammond speakers not having input grid blocking condensers must include a type 2 Adapter at each speaker. This will provide the needed tremolo control voltage isolation, and yet allow full tremulant control on the later Leslies wherever they might be connected in the chain.

The Adapter doesn't affect amplifier operation, but does change the impedance value on the amplifier extra speaker socket. So any additional speaker following the adapter must have its cable connected to the socket in the Adapter box instead of the extra speaker socket of the amplifier. If this is not done, hum will be passed on to the additional amplifiers.

#### **Earlier Leslies In Multiple Speaker Installations**

When earlier model Leslies are to be used in combination with later Leslies, because of circuit and electrical balancing complexity, the tremolo on-off control circuit is desirably omitted for the earlier Leslies. With the on-off control circuit omitted, the tremulant will operate continuously on these speakers, but the type 2 tremolo controlled later Leslies, will have full on-off tremolo control.

A possible way to include tremolo control on the earlier Leslies is to add a wire along the speaker cable to allow switching AC power on and off at the tremulant motor sockets of the amplifier.

#### **Modification of Earlier Leslies**

Earlier Leslies can be updated and made compatible with later Leslies. It is necessary to send the amplifier only from the early Leslie to the Electro Music factory for modification to include the improved type 2 tremolo control system.

After modification, the speaker becomes fully compatible to hookups with later Leslies, and no longer requires use of Adapters. If a type 2 tremolo control kit isn't at hand, order one when the amplifier is sent in for modification.

## Echo (Speaker Selector) Controls

In electric organ usage, multiple speakers are often used in separate groups. Those located relatively adjacent to the console are designated as Main speakers and the speaker or speakers some distance away are called Echo speakers.

An Echo control at the console is a switching device which allows the organist to use either the Main speaker, Echo speaker, or both in ensemble. Leslie 3H and 3M Echo controls will provide this kind of operation when used with either Leslie or Hammond speakers.

The 3H control is for use with all larger consoles. The 3M is designed for use with all Spinet models. Other make Echo controls are not compatible for use with Leslie speakers unless modified to ungrounded type. Use Leslie echo control diagrams in the speaker instruction book as guide for modification, if required.

## Independent Control of Tremolo

### For Separate Groups of Speakers

Multiple speaker installations with an Echo (Speaker Selector) switching arrangement and having Leslies in Main and Echo channels can be arranged to have independent on-off tremolo control for each channel.

It will require installation of two tremolo control kits (one for each channel) at the console. A tremolo control kit is furnished with each Leslie speaker.

A simple internal wiring modification in the 3H Echo control terminal box is required. This modification doesn't change the performance of the 3H control. Its purpose is to separate the tremolo control voltage for each channel. All information is included in identified instruction diagrams, for 3H Echo control.

## AC Power for Multiple Speaker Installation (5A Relay)

In planning a multiple speaker installation, consideration must be given to AC power required, because with regular cable connections, AC power for the speaker cabinets is all drawn through the console cir-

cuits. The console power circuits are designed to handle up to 620 watts before considered as overloaded.

This means that if the combined cabinets require more than 620 watts, some of the speakers should be powered by an AC source outside of the organ console. Watts required for each cabinet is shown on its nameplate.

A convenient way to energize speakers requiring a separate source of power is to plug in a Leslie 5A Power Relay at each such speaker between the console cable and connecting prongs at the speaker cabinet. The Relay power cord is to be plugged into an AC outlet. Such an installation will provide for speaker AC power on-off control with the organ console switch, but with no overload problems on console circuits.

## Volume Control Settings on Multiple Speakers

For maximum undistorted loudness from each speaker adjust the volume control per instructions on the back of the Leslie.

Where musical effect rather than maximum possible loudness is important, it is desirable to hear some sound from several speakers at a given listening position. The volume controls on the Leslies can provide for loudness balancing between speakers to avoid having one speaker overpower the others in overall sound contribution.

Experimental trials in adjusting loudness on various speakers of a multiple system is urged to derive full benefit of musical possibilities.

## Phasing

When two or more adjacent speakers are used in ensemble, they should be phased so pedal frequencies will add instead of cancel.

If improper phasing of adjacent speakers is suspected, try reversing the red and black cable wires (pins 1 and 6) at one speaker. These wires should be connected to give loudest pedal output when adjacent speakers are sounding together.

APPLICATION	CONNECTING CABLES CHART	ORDERING INFORMATION
EARLIER CONSOLE TO SPEAKER, EXTENSION FROM CONSOLE CABLE TO SPEAKER.  EXTENSION BETWEEN SPEAKER CABLE AND SPEAKER. 30 FT LONG ONLY	<p>ASSEMBLED WITH CONNECTORS AS SHOWN 30 FT 6 COND.</p>	LESLIE PART NO. 727
LARGE OR SPINET CONSOLE TO ECHO SPEAKER.  30 FT. LONG ONLY	<p>ASSEMBLED WITH CONNECTORS AS SHOWN 30 FT 6 COND.-5 USED</p>	LESLIE PART NO. 3M-1  THIS CABLE IS FURNISHED AS PART OF 3M ECHO CONTROL KIT.
LATER MODEL CONSOLE TO SPEAKER. SPEAKER TO SPEAKER. CONSOLE TO ECHO SPEAKER.  CUSTOM LENGTH	<p>ANY LENGTH 6 COND.-5 USED</p>	NOT AVAILABLE ASSEMBLED. ORDER THESE PARTS 727-1 BULK CABLE (SPECIFY LENGTH) 727-3 SOCKET AND CAP (6 POLE) 727-4 PLUG AND CAP (5 POLE)
LARGE OR SPINET CONSOLE TO ECHO SPEAKER.  CUSTOM LENGTH	<p>ANY LENGTH 6 COND.-5 USED</p>	NOT AVAILABLE ASSEMBLED. ORDER THESE PARTS 727-1 BULK CABLE (SPECIFY LENGTH) FOLLOWING NEEDED PARTS ARE INCLUDED IN 3M ECHO CONTROL KIT. 727-3 SOCKET AND CAP (6 POLE) SPADE LUGS

**Leslie 3H Echo (Speaker Selector) Control  
For Larger Series Hammond Organ  
Installation Instructions**

1. Mount the Speaker Selector switch case assembly at the keyboard rail location to suit the organist. It can be mounted at either the right end of the rail to balance the appearance, or alongside the tremolo switch.
2. Mount the Echo terminal box inside the generator compartment and near the pre-amplifier.
3. Unbolt and lift the manuals to pass the Echo switch cable into the generator compartment.

An alternate way is to run the cable down along the corner formed by the console inner side and the kneeboard. With back of console removed, cut a small notch in the shelf to allow switch cord entry without pinching the wires.

4. On organ consoles with an outlet box for the speaker connector, a five pole socket can be installed in place of a knockout, and wired to accommodate a plug-in connector for the Echo

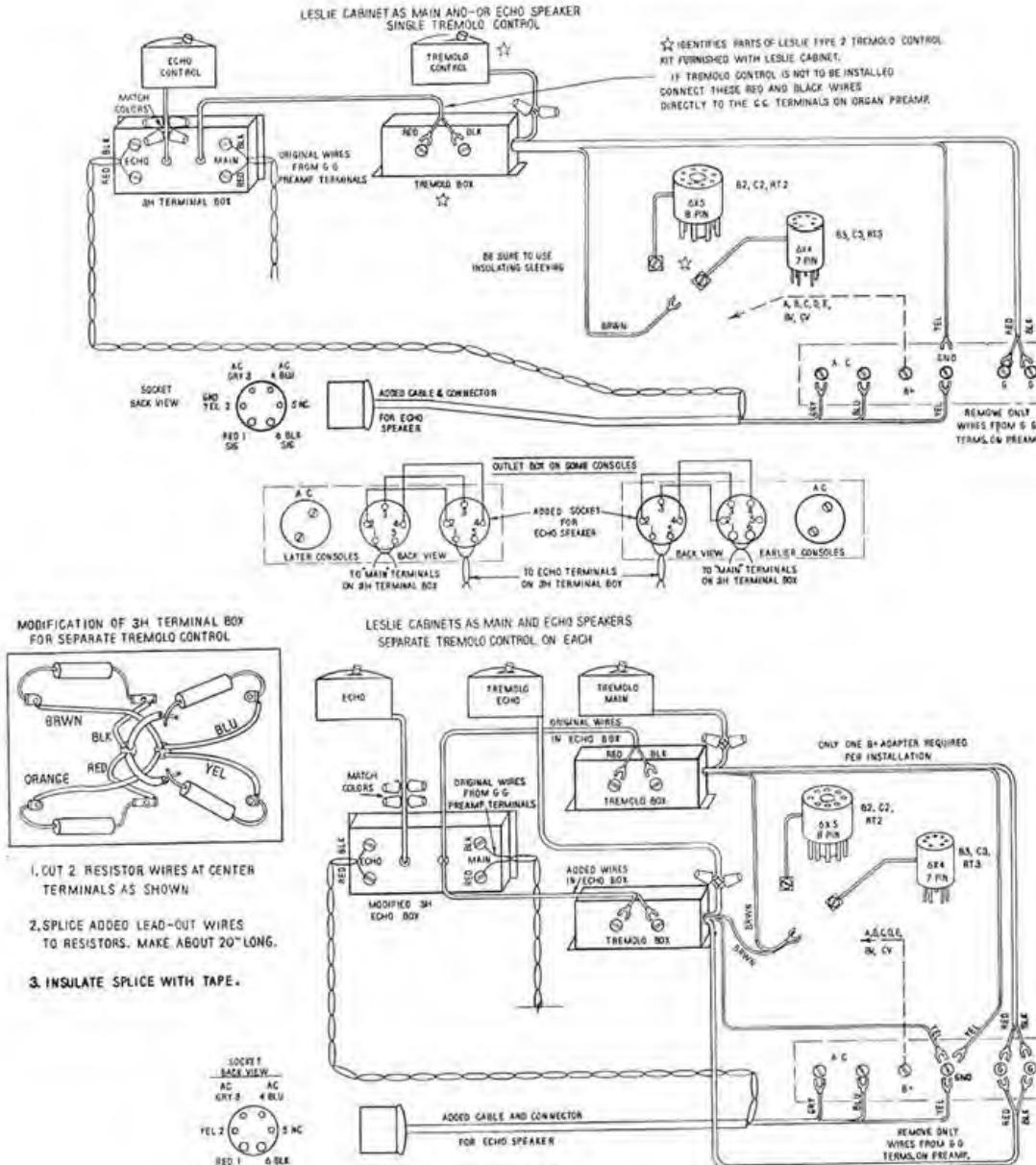
speaker cable. Wiring is shown in the diagram for the Echo control installation.

5. If the outlet box connector method is not used, the Echo speaker cable can be brought into the generator compartment by way of a notch in the console shelf.

For this method of cable installation order a complete 3M-1 30 ft. cable or make up a cable to suit. The 3H kit includes a speaker cabinet cable connector socket and cap plus several spade lugs, but no cable. Order cable in a length to suit. Refer to Cables Chart for details.

If a Hammond tone cabinet is to be used along with a Leslie in the hookup, check to see if it has input grid blocking condensers. If not, be sure to include a Leslie type 2 adapter between the Hammond input plug and the cable connector. If in doubt, use the Adapter—it causes no harm.

Connect wiring as follows:



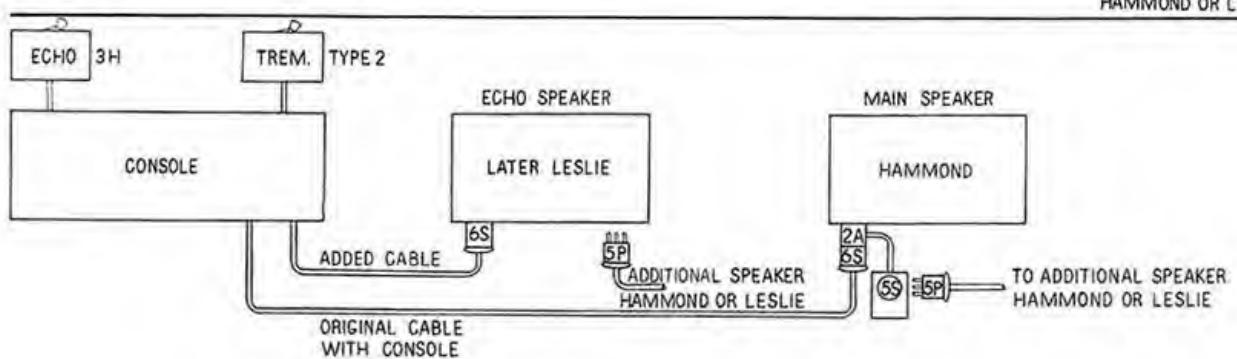
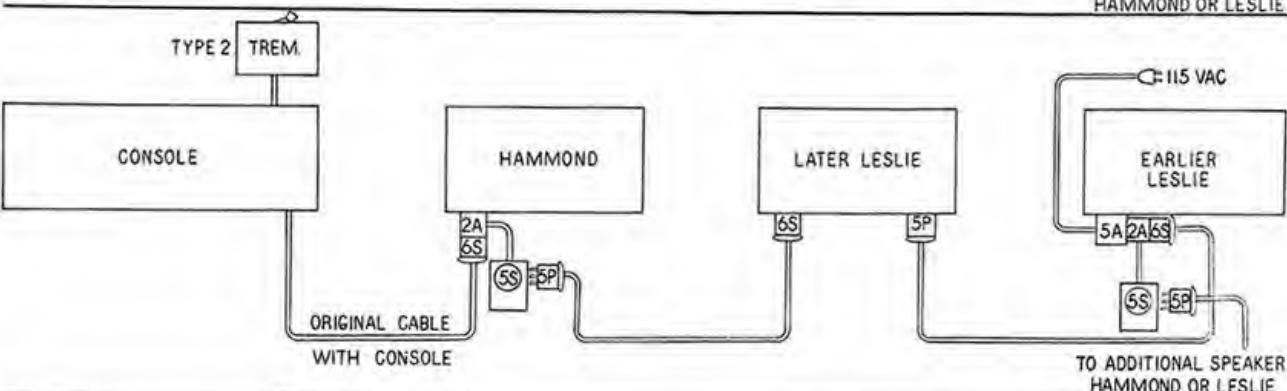
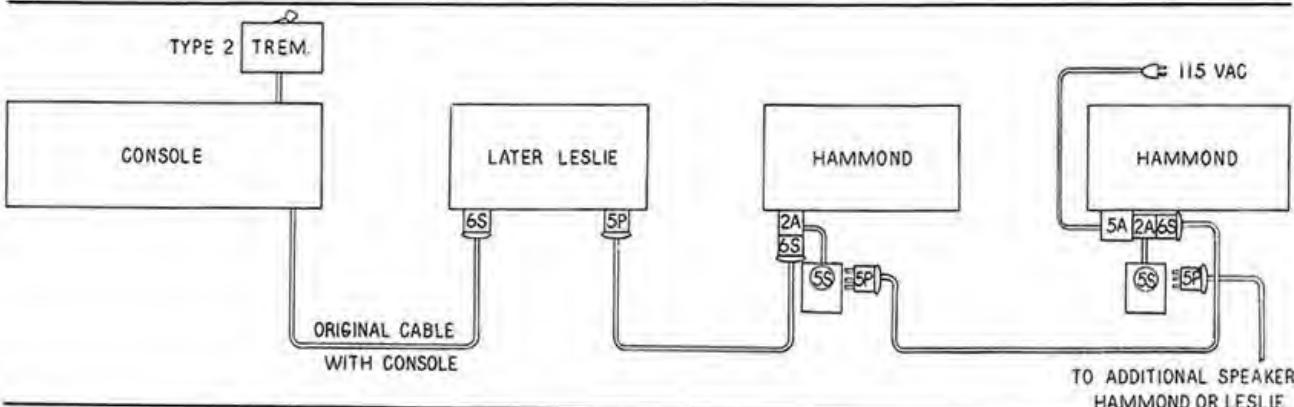
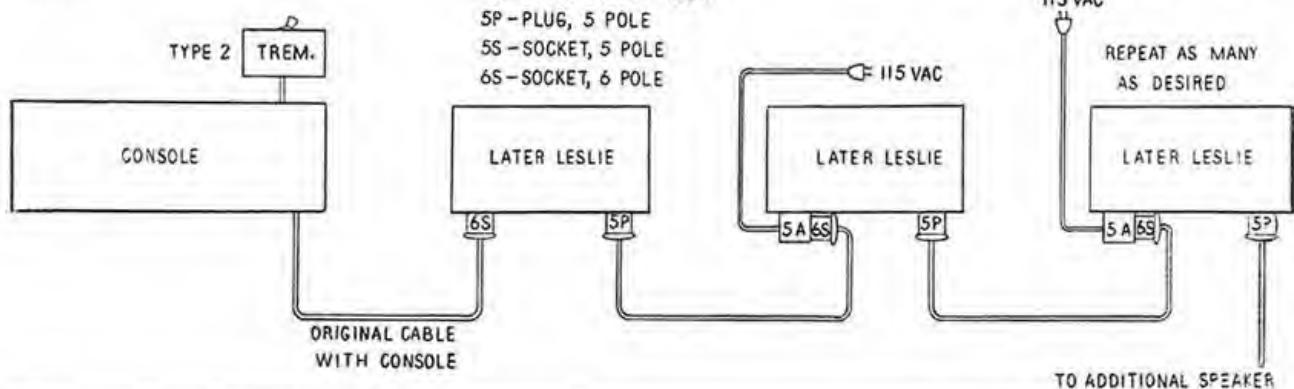
**GENERAL GUIDE FOR MULTIPLE SPEAKER INSTALLATIONS  
SHOWING HOOKUPS TO INCLUDE  
HAMMOND WITH LESLIE SPEAKERS**

ON HAMMOND CABINETS WITH  
GRID INPUT BLOCKING CONDEN-  
SERS, TYPE 2 ADAPTER IS NOT  
NEEDED.

KEY TO ACCESSORY AND CONNECTOR DESIGNATIONS

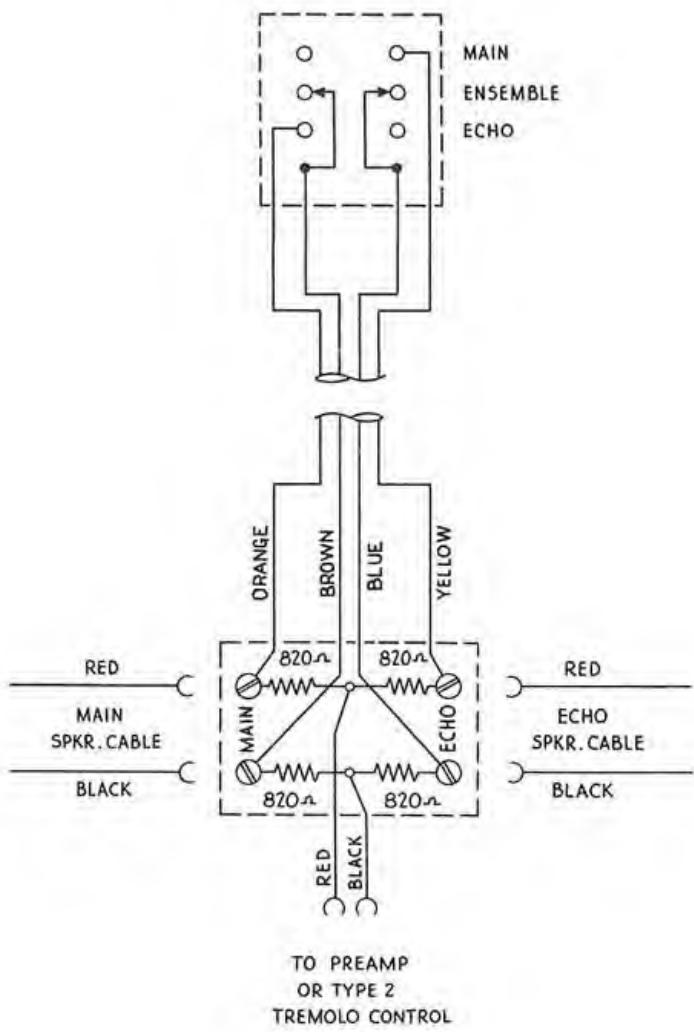
2A - TYPE 2 ADAPTER  
5A - LESLIE POWER RELAY  
5P - PLUG, 5 POLE  
5S - SOCKET, 5 POLE  
6S - SOCKET, 6 POLE

EARLIER LESLIE - SERIAL BELOW 5200  
LATER LESLIE - SERIAL ABOVE 5200

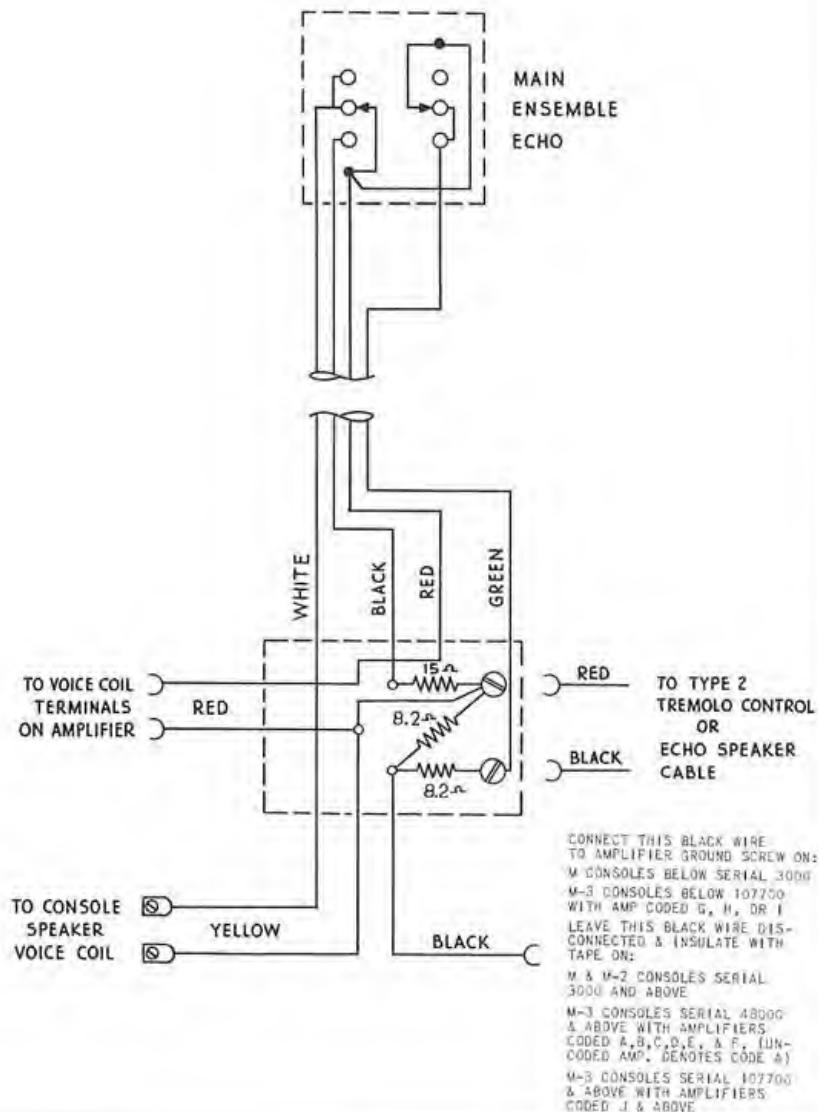


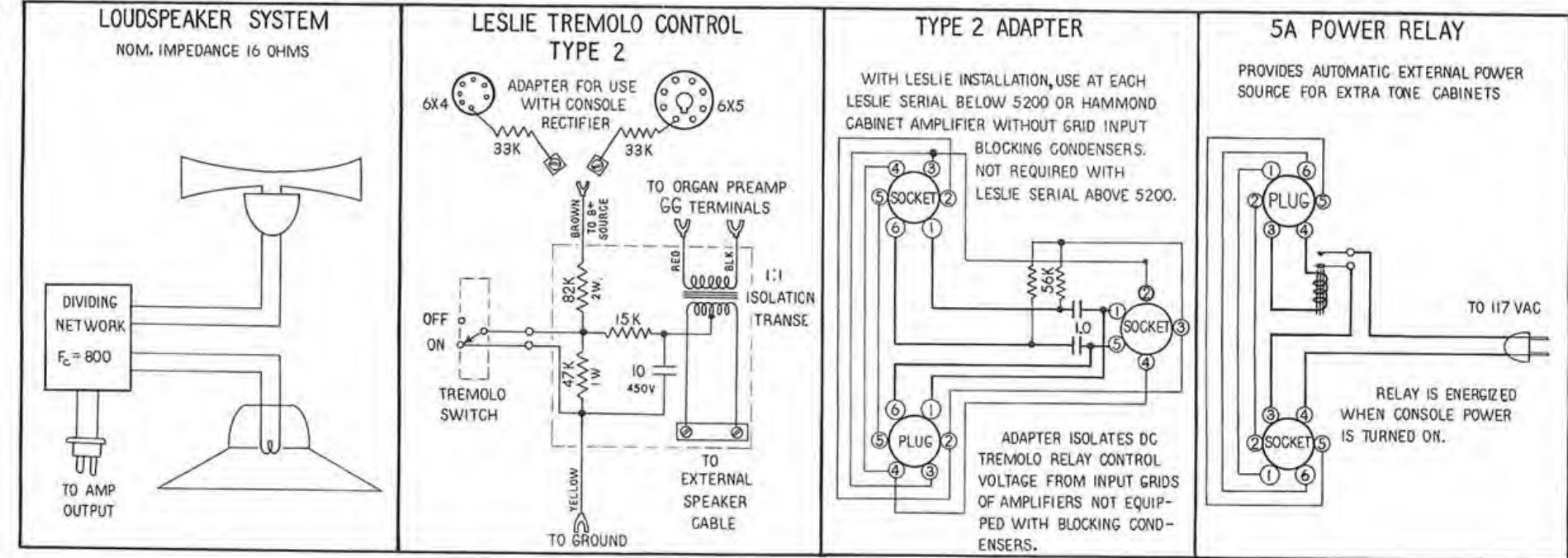
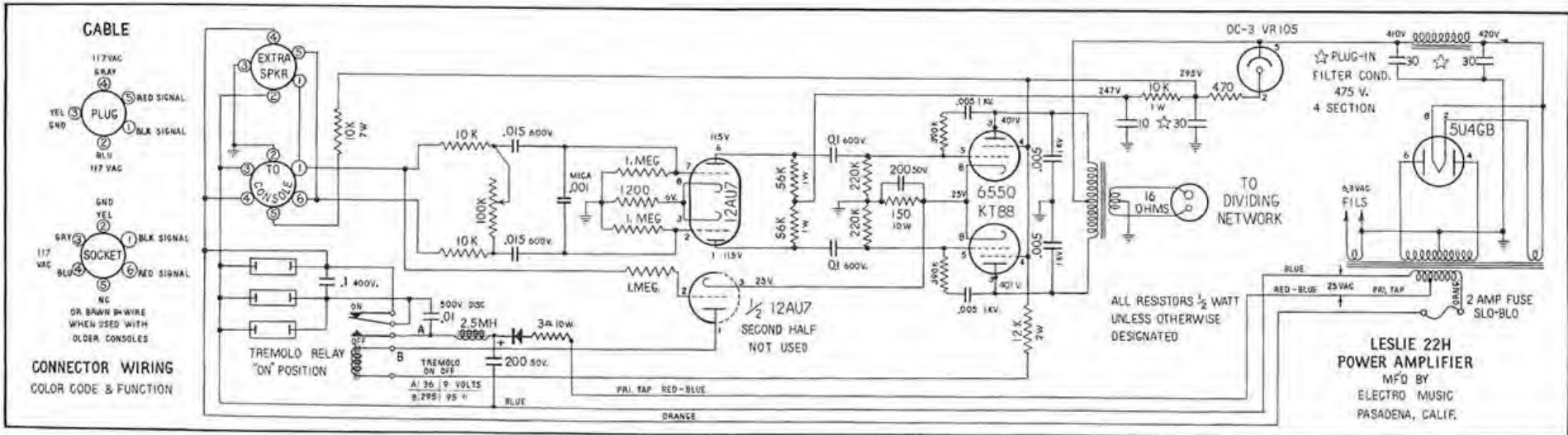
# LESLIE ECHO CONTROLS

**TYPE 3H**



**TYPE 3M**





**SERVICING AND TECHNICAL  
INFORMATION  
ON COMPLETE LESLIE SPEAKER CABINET**

**Replacement Parts for Servicing**

Replacement transformers, filter chokes, and tremolo relays, should be obtained from the Electro Music factory. Standard type parts such as fuses, sockets, resistors, and condensers, can be obtained from radio parts supply stores. The detailed parts list with this manual will give full parts replacement information.

**Amplifier and Electrical**

Amplifier is removed from cabinet by taking out the one screw that holds the front end of the amplifier to the bottom of the cabinet. After the two motor plugs and speaker plugs are removed, the amplifier may be withdrawn. When pushing the amplifier back into place, align the back end of the chassis in approximate position so that the amplifier guide and hold-down clamp will engage the amplifier.

**Fuse**

The amplifier uses a replaceable Slo Blo 2 amp. fuse to protect the power supply against most short circuits. Before replacing a blown fuse, determine the cause of fuse failure. Do not leave a fuse of higher current rating than specified in the amplifier.

**Screen Voltage Regulation on Power Tubes**

This amplifier uses a new and relatively simple regulating circuit to hold the output tubes screens at the best operating voltage regardless of signal level variations. The result is maximum efficiency in getting the greatest useful power output for the power total consumed.

Gas regulator tubes will maintain a constant voltage drop regardless of current variations, within rated limits. By proper choice of gas tube relative to the power supply voltage, a closely held voltage is made available for the screens. Parts used and functions are as follows:

1. 0C3-VR105 Regulator tube provides constant voltage reduction in a series circuit to the output tubes screens.
2. 470 ohms 1/2 watt resistor—not critical in value. Acts to suppress possible gas tube oscillations caused by screen current variations. It also acts as a fuse in case of accidental screen circuit short.

**Tremolo Control**

Non-operation of the Leslie tremulant can be corrected by checking the following:

1. Make certain the wiring is done exactly as shown in the figure on page one. Deviations on this simple installation will cause improper operation.
2. Check the connecting cable for shorts or other conditions which would alter the DC voltage superimposed on the signal line. It should be on the order of 100 volts.
3. If a non-Leslie speaker selector (Echo) switch or Hammond cabinet is included in the hook-up, make certain the echo switch or cabinet connection

doesn't cause the superimposed DC voltage to be grounded out.

4. Should none of the above reveal the non-operation cause, then a detailed check of the Leslie tremolo circuit components both in the console and Leslie amplifier should be made against the wiring diagrams in this manual.

**How the Type 2 Tremolo Control Operates**

The type 2 tremolo control circuit superimposes a DC controlling voltage on the signal line to the speaker cabinets. This is used to actuate a tube operated relay circuit for turning power on and off to the tremulant motors without need of control wires from the console to the speaker cabinets.

The tremolo control box installed at the console has a DC isolation transformer in the signal line. Without affecting the organ generator or amplifier circuits in any way, a positive voltage can be applied to the speaker signal line at the transformer center tap. A 10 mfd. condenser at the center tap puts the signal line at low audio impedance to ground, and yet allows changes in DC potential.

The relay control tube is one triode of a 12AU7. This triode has the relay coil and a current limiting resistor in its plate circuit. The cathode is connected to the cathodes of the output tubes and so is about 25 or more volts above ground. With the grid at ground potential, this cathode potential cuts off the plate current flow. With a DC potential on the signal line greater than the biasing 25 volts, the grid is raised up to the cathode potential and the triode draws plate current to operate the relay.

The control triode grid has a one megohm isolating resistor. This resistor prevents the grid from being driven positive with respect to cathode, and also prevents any effect on the operation of the audio on the signal line. Because the resistor also acts as a limiter, the DC control voltage is not critical and allows circuit operation over wide variations in B+ and AC line voltages.

The furnished tube adapters used to obtain the controlling voltage from the organ amplifier, have internal dropping resistors which protect the power supply in case of an accidental short circuit.

**Distortion**

Distorted sound is often caused by a too high setting of the Leslie volume control. Amplifier gain is purposely greater than necessary, so low output consoles can still provide full sound power output from the Leslie. Arbitrary setting of this volume control at maximum will surely result in distortion when the organ swell control is fully opened. The back card of the cabinet has instructions on setting the volume control for maximum undistorted output.

**Sound Brilliance**

A variation in high frequency output from the Leslie can be arranged. The amplifier includes a .001 mfd. capacitor from grid to grid of the balanced input stage. By changing the value of this capacitor, variations in brilliance of tone can be obtained.

To increase brilliance, change the value to about 500 mmfd. or less. To decrease brilliance, shunt additional capacity across existing one or replace with a greater value to obtain desired balance. Do not change the output transformer primary shunting condensers.

#### Voltage Readings

If the amplifier develops difficulties resulting in unsatisfactory or non-operation that is not remedied by tube or electrolytic condenser replacements, the various voltages should be measured and compared to the voltages shown on the circuit diagram. The voltages indicated were measured with a 20,000 ohms per volt voltmeter, and differences in meter resistance and line voltage variations as well as parts tolerances should be kept in mind. If any abnormally high or low voltage is noted, it usually indicates a defective part in the associated circuit.

#### Transformer Replacement

If the output transformer is replaced, the two plate leads should be as short as possible and lie close to the chassis.

#### Electrolytic Condensers

Practically all modern amplifiers contain electrolytic condensers. These have a definite life expectancy, and must eventually be replaced. The Leslie amplifiers use the finest electrolytic condensers obtainable, and experience has shown that many years of trouble free service can be expected.

In view of the fact that they will eventually wear out, all of the electrolytic condenser units on the amplifier are contained in a single plug-in unit that can be replaced as easily as a tube. The condenser is a four section 30-30-30-10 mfd. 475 volt unit.

#### Tubes

Tubes are probably the most common source of amplifier difficulties. Checking in a tube tester does not always show all of the possible tube faults. The surest method is substitution with a new set to eliminate these units as a source of trouble. For reliable operation, it is generally recommended that tubes which have had a thousand hours use service be replaced. In this way, many difficulties can be avoided.

New tubes are not always perfect and can cause hum plus other troubles. If troubles come up at tube replacement time, the new tubes should be carefully checked or substituted.

#### Line Voltage

Exceptionally low or high line voltage may cause difficulties with amplifier operation. If the line voltage falls below 100 volts, unsatisfactory performance will result. Low line voltage can be caused by poor contacts in the cable wiring or exceptionally long cable. This condition should be corrected by use of heavier cable or some kind of voltage regulator. Adding the Leslie 5A relay is an easy way to overcome low line voltage due to long cable.

#### Automatic Electric Braking on Tremulant Rotors

When the tremolo control switch is in off position,

braking of the tremulant motors is obtained by having the control relay apply a direct current to the motors. During the off time, the direct current flows through the motors continually. No harm is done because the current is substantially below normal running ratings.

The DC braking voltage is obtained by rectifying and filtering a 25 volt tap on the power transformer primary. The following parts and functions are involved:

1. Silicon diode rectifier.
2. 200 mfd. 50V filter condenser.
3. Filter choke coil to eliminate switching clicks in speaker.
4. 3 ohm current limiting resistor to protect the silicon rectifier from current surges.

#### Horn Reflector Replacements

On the damaged reflector, cut the stand-off pins so they can be pulled out with a pair of slip joint or "gas" pliers.

In assembling the new reflector, make sure it is put on so the cut edge will be at the top of the horn when it is in operating position. To hold the reflector without rattling, use the special cement furnished by Electro Music.

#### Loudspeaker System and Dividing Network

The Leslie uses a full two way system with two separate speakers. Pedal and midrange tones are generated by a heavy duty 15 inch speaker with Alnico 5 D.G. Permanent magnet. Its nominal impedance is 16 ohms. Upper middle and highest tones are generated by a compression sound chamber driver unit also using Alnico 5 D.G. permanent magnet. Its nominal impedance is 16 ohms.

The 15 inch speaker is mounted in a matched bass reflex enclosure. It is therefore important that the cabinet back is in place and securely fastened. The high frequency driver is loaded by means of a rotary horn. Only one of the horns in the upper rotor radiates sound. The other horn dynamically balances the assembly to eliminate vibration. A small cotton acoustic filter is placed in the throat of the horn. It also prevents dust from entering the driver unit. Do not remove this filter.

The two specialized range speakers are connected to the amplifier via a two half section M derived frequency dividing network (crossover). This network electrically separates the bass and treble range output of the amplifier, and directs the proper signal to each speaker. The nominal separation occurs at 800 cps. The impedances used in the loudspeaker system allow a dividing network design of extremely rugged and electrically stable parts. It is very unlikely that trouble will ever be experienced with this element.

#### Speaker Problems

Because of the extremely strong permanent mag-

netic fields with both speakers, it is inadvisable to attempt cone replacements or repairs involving disassembly. The Electro Music factory will either repair a faulty unit or supply a replacement.

Should the treble speaker become inoperative for some reason, emergency operation of the cabinet can be arranged. Unplug the bass speaker from the dividing network and plug it direct to the amplifier output socket. There will, of course, be a lack in musical quality until the complete system is restored.

Suspected low output from the dividing network output can be checked by the same procedure as above.

#### **Motor Maintenance**

After several years of typical service, or a reasonably long period in commercial use, the motors might accumulate lint and dust. This accumulation interferes with proper ventilation and oiling. Time invested in cleaning the motors is well repaid by longer life. The motors can be removed easily and cleaned with cleansing solvent.

For cleaning purposes, before a motor can be completely taken apart, the pulley, pulley support ring, and oil tube assembly must be removed. When removing the end covers, be sure to note or mark the position of the bottom end cover with respect to the laminations. If this should be rotated relative to its original position, bearing misalignment will result and the motor will be noisy or even bind.

After reassembly, if there is some noise during motor operation, it's probably due to temporary bearing unseating. A light tap with a fairly heavy tool on the laminations side will shake the assembly into proper position.

The mounting brackets used with the motors are adjusted to obtain 5 $\frac{1}{8}$ " between centers of mounting holes. If the brackets are bent, they should be straightened to obtain this dimension. On 22H, upper and lower motors are interchangeable if the proper pulley is used. Motor pulley is held on to the shaft by the center screw, and after this is removed, the pulley may be pulled from the shaft. The metal three groove pulley is for upper rotor and the single groove pulley is for lower rotor use.

#### **To Remove Upper Motor**

Remove the motor power plug from socket, and remove the two wing nuts. Then the motor can be removed from the cabinet. **IMPORTANT:** The upper motor must run counterclockwise when viewed from the top or pulley end. Otherwise, the upper tremulant rotor will not come up to speed. If the motor is disassembled or another motor substituted, the rotation should be checked to be sure it is *counter-clockwise*.

#### **To Remove Lower Motor**

Remove the motor power plug from the amplifier socket and remove the two wing nuts that hold it to the shelf. The motor will drop down for removal. When replacing this motor, first position the belt on the motor pulley before it is lifted into place onto the mounting screws. Because the front wing nut controls

the tremulant drive belt tension, this must be adjusted whenever the motor is replaced. To do this, pull the front wing nut to the left until the belt is tight. Release the wing nut and the belt will assume its proper tension. Tighten the wing nut at this position. Do not attempt to stretch the belt tight and hold it in that condition with the wing nut. Too much tension will result in noise and hard rotor starting.

#### **Belt Replacement**

For average service, the belts usually last several years. In the event of any excessive belt wear, the pulley and mountings should be examined for rough surfaces or misalignment that might cause the wear.

#### **Upper Belt Replacement**

Remove the upper compartment cover and pre-stretch the new belt by pulling it out to full length. Place it over one horn and then the other alternately; then on desired motor pulley groove and idler pulley.

Three tremulant speeds are available by choosing one of the three grooves on the motor pulley. Center groove provides standard tremolo, upper groove a slow tremolo, and lower groove a fast tremolo.

#### **Lower Belt Replacement**

A frayed or worn lower belt can cause noise by striking the lower shelf or belt guard and should be replaced as follows: Remove the large center back and lower compartment cover. Along the rim of the bass speaker, remove the eight mounting screws. Remove the connecting cable plug from the dividing network. The bass speaker can now be lifted from the shelf and out of the cabinet. To avoid possible cone damage, lift straight up for a short distance.

Pull the exposed rotor support from shaft. Place the new belt on the large pulley and pass the rest of the belt between the rotor and shelf towards the driving motor.

Remove the motor holding wing nut nearest the cabinet back to partially drop the motor. Temporarily, hook the new belt over the screw that had the wing nut.

Replace the bearing support on the rotor shaft and position the ends in the shallow locating channels at the speaker opening hole. Align the holes in the support with the speaker mounting holes in the locating channels.

Place the bass speaker back in position and install the two screws that hold the speaker at each end of bearing support. These screws should be just started in position and then the other six screws started. After all eight screws are in position, they may be tightened.

Place the new belt on the driving motor pulley and put the motor back in position using the original holding wing nut.

#### **Belt Tension Adjustment**

Next, adjust the belt tension by first loosening the front motor wing nut only and pulling the motor assembly to the left until the belt is stretched. Release the wing nut and the belt will assume its proper tension. Tighten the wing nut at this motor position. Do

not attempt to stretch the belt tight and hold it in that condition with the wing nut. Noise and hard starting will result.

With proper belt adjustment, some slipping will be heard when the motor starts and stops. Do not attempt to eliminate all slippage by belt tightening, as this will prevent proper operation.

#### **To Remove Treble Speaker and/or Upper Tremulant Rotor**

1. Remove upper cover and belt.
2. Remove center compartment back.
3. Remove treble speaker unit plug from dividing network.
4. Remove the three screws in the rim of the treble speaker unit and drop straight down and out. The upper tremulant rotor may be removed by turning it sideways.

**IMPORTANT:** When replacing these parts, be sure the rubber and metal thrust washers are on the spindle so that the tremulant rotor will operate at the correct height and bass tones will not produce thrust bearing noises. The rubber washer is first placed on the spindle and then the metal washer is placed on top of the rubber washer.

#### **Idler Pulley**

The spring mounted idler pulley provides proper belt tension, and in the event the spring mounting becomes bent, it should be readjusted by bending so that it is aligned with the belt.

#### **To Remove Bass Speaker**

Remove center compartment back and the screws in rim of bass speaker. Disconnect plug from dividing network. Avoid damage to cone by lifting speaker straight up for a short distance before taking out of cabinet.

#### **To Replace Bass Rotor Bearings**

##### **Upper Bearing**

1. Remove bass speaker.
2. Remove top half of bearing clamp. The ball bearing can now be lifted out and replaced.

After the bearing clamp nuts are tightened, if the new bearing is found to be slightly loose, remove the bearing support assembly from the cabinet. Disassemble, and bend the lower half of the bearing clamp so it will apply more pressure to the ball bearing.

##### **Lower Bearing**

1. Lay cabinet on floor so that bottom is accessible.
2. Remove the two screws that fasten the bearing mounting plate to the cabinet, and entire bearing assembly can be pulled from the shaft. Be sure to save the flat metal washer between the rotor and lower bearing grommets. It is important that this washer be in place when bearing is reassembled.

3. Remove the top half of bearing clamp to replace the ball bearing assembly.
4. Upon reassembly of bearing holder to rotor shaft, make certain the flat washer is included between the rotor and bearing grommets.

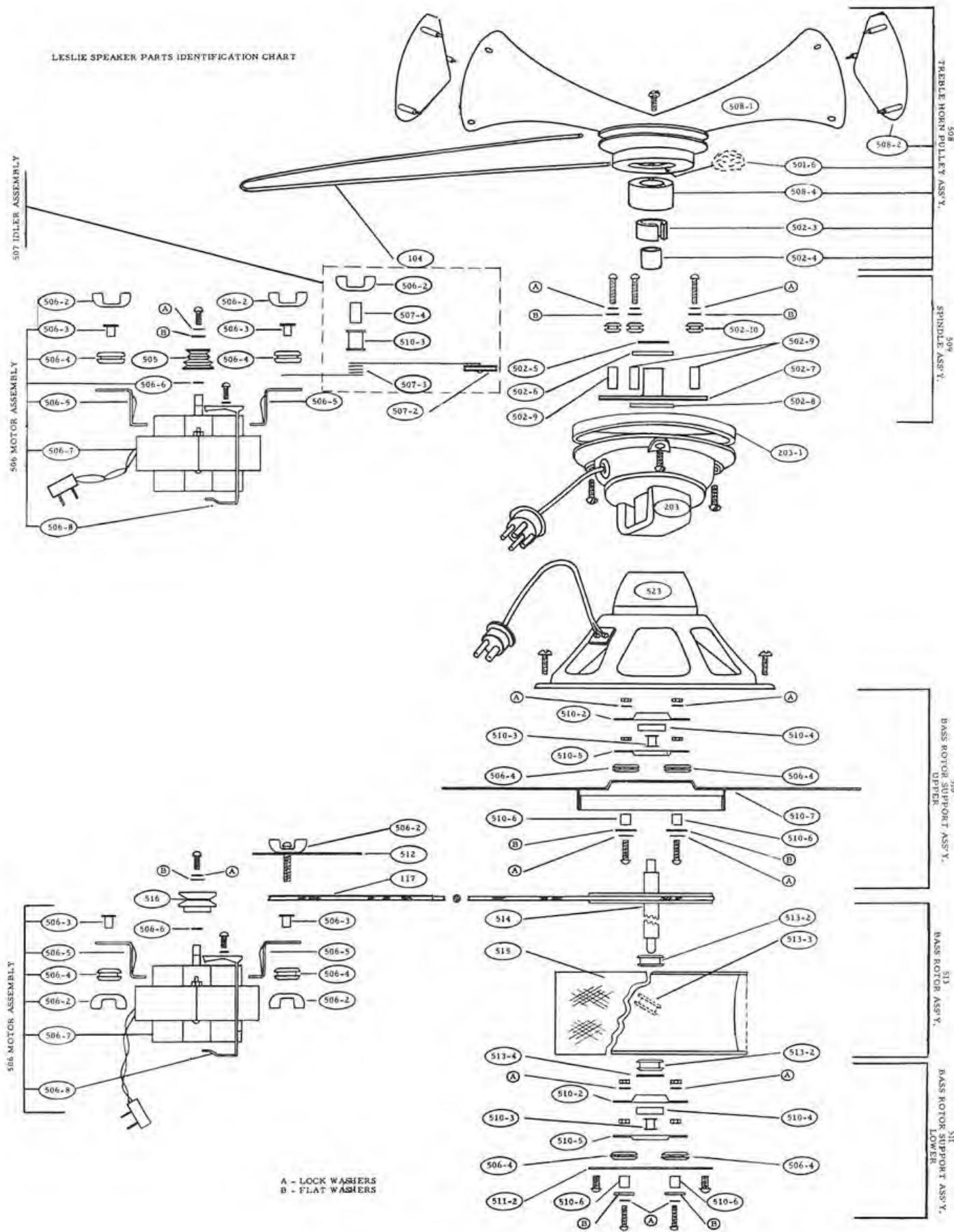
#### **To Remove Lower Tremulant Rotor**

1. Remove bass speaker.
2. Remove upper bearing support and belt.
3. Using the large pulley as a handle, remove the tremulant rotor shaft by twisting and pulling up at the same time. The tremulant rotor then will be freed to be removed towards the back of the cabinet. Be sure to save the metal flat washer found between the bearing and rotor grommets.
4. Replace the tremulant rotor with the sound deflector surface curved downward. Make certain the flat metal washer is in place between the bearing and rotor bottom grommets. When replacing the rotor shaft to the rotor, a little oil or Vaseline may be used as a lubricant. Grommets are made of Neoprene and will not be damaged by such lubricants.

When inserting the shaft, hold the rotor in a position that will allow the lower shaft end to enter the bearing grommet without displacing the flat metal washer between the bearing and rotor grommets.

To simplify the alignment of the shaft with the lower bearing, it may be easier to place the cabinet on the floor and remove the lower bearing assembly as in replacing the lower bearing. Also, in this way, it can be determined that the washer between the ball bearing grommet and the tremulant rotor grommet is properly in place.

**LESLIE SPEAKER PARTS IDENTIFICATION CHART**



## 22H LESLIE ORGAN SPEAKER PARTS LIST FOR HAMMOND ORGANS

**IMPORTANT: When ordering parts, serial numbers of instrument must be furnished to insure correct parts being supplied.**

Part numbers of three or less digits are complete assemblies. Part numbers with dash numbers are individual parts from complete assemblies. (Example: for complete motor assembly, order Part No. 506.) (For motor bracket order Part No. 506-5.)

### EQUIPMENT USED AT HAMMOND CONSOLES

428	<b>Type 2 Tremolo Control Complete</b> (Brown, ivory, ebony control cases)
428-1	Assembly, tremolo switch with cable attached, plastic case and knobs. (State color)
428-3	Plastic tremolo case only, with cover (brown)
428-4	Plastic tremolo case only, with cover (ivory)
428-5	Plastic tremolo case only, with cover (ebony)
428-10	Switch retainer (two used) specify "Tremolo"
428-6	Push-on knob, brown
428-7	Push-on knob, black
429-1	Tremolo electrical switch only
428-8	B+ adapter 6X4 (small)
428-9	B+ adapter 6X5 (large)
428-2	Tremolo isolation transformer only
3H	<b>Echo Control Complete</b> <b>For Large Consoles</b> (brown, ivory, ebony control cases)
3H-1	Assembly, Echo switch with cable attached, plastic case and knob. (State color)
3H-2	Plastic echo case only, with cover, (brown)
3H-3	Plastic echo case only, with cover, (ivory)
3H-4	Plastic echo case only, with cover (ebony)
428-6	Push-on knob, brown
428-7	Push-on knob, black
3H-5	Echo electrical switch only
428-10	Switch retainer, (two used) specify "Echo"
3M	<b>Echo Control Complete</b> <b>For Spinet Consoles</b>
3M-1	Speaker connecting cable, complete (30 ft. long with required connectors)
3M-2	Speaker plug adapter (For use in M-3 console)

3M-3	Assembly, echo switch with cable attached, plastic case and knob. (State color)
3H-2	Plastic echo case only with cover, brown
3H-3	Plastic echo case only with cover, ivory
3H-4	Plastic echo case only with cover, ebony
428-6	Push-on knob brown
428-7	Push-on knob black
3H-5	Echo electrical switch only
428-10	Switch retainer (two used)

### 22H AMPLIFIER

525-1	Power transformer
525-10	Output transformer
525-11	Filter choke
525-5	Chassis mounting strip (2 used)
525-6	Rubber shoulder bushing (4 used)
525-7	Metal bushing (4 used)
525-8	Amplifier hold down clip
525-12	Relay
510-6	Relay mounting bushing
502-10	Relay mounting rubber grommet
525-13	Motor outlet socket (3 used)
525-21	Filter condenser socket
730-3	Speaker socket
725-15	Filter cond. plug-in (30-30-30-10-475V)
525-17	Fuse holder
525-18	Volume control (100K ohms)
525-19	Bias resistor (150 ohms 10 watt)
525-20	Brake condenser (200 mfd. 50 volts)
525-22	Brake suppressor coil
525-23	Brake resistor (3 ohms 10 watt)
525-24	Brake silicon rectifier

Parts such as resistors, condensers, and sockets available from radio stores.

### ACCESSORIES

5A	<b>Power Relay</b> — for Multiple Speaker installations. Provides automatic external power source for extra tone cabinets.
Type 2	<b>Adapter</b> required for Hammond and early Leslie speakers when used with later Leslies
727	<b>Six Conductor Extension Cable</b> Complete with attached six pole plug and socket. 30 feet long only

3M-1	<b>Echo Speaker Connecting Cable Complete</b>	523	<b>PM Bass Speaker</b>
	Six pole socket on one end and spade lugs on other. 30 feet long only.		NOTE: Replacement cones, not available. Factory installed only.
727-1	Bulk six conductor cable only, specify any length.	516	<b>Single Groove Motor Pulley (Lower)</b>
727-2	Six pole plug and cap	117	<b>Bass Rotor Belt</b>
727-3	Six pole socket and cap	510	<b>Bass Rotor Support Assembly, Upper</b>
727-4	Five pole plug and cap	510-2	Bearing clamp, upper half
22H	<b>SPEAKER CABINET</b>	510-3	Bearing grommet
508	<b>Treble Horn-Pulley Assembly</b>	510-4	Ball bearing
508-1	Horn pulley moulding only	510-5	Bearing clamp, lower half
508-2	Horn reflectors (2 used)	510-6	Metal bushing (2 used)
501-6	Cotton filter	510-7	Crossbar support
502-3	Felt oil reservoir pad	506-4	Rubber Grommet (2 used)
502-4	Oilite bearing insert	513	<b>Bass Rotor</b>
508-4	Bearing housing		(With grommets, less cover)
509	<b>Spindle Assembly</b>	513-2	Rubber grommet (ends, 2 used)
502-5	Metal thrust washer	513-3	Rubber grommet (center)
502-6	Rubber thrust washer, 1-1/16" hole	513-4	Metal washer
502-7	Spindle and mounting plate	514	<b>Bass Rotor Shaft and Pulley</b>
502-8	Rubber spacing washer 5/8" hole	515	<b>Bass Rotor Cloth Cover</b>
502-9	Spacer, spindle mounting (3 used)	511	<b>Bass Rotor Support Assembly, Lower</b>
502-10	Rubber grommet (3 used)	510-2	Bearing clamp, upper half
203	<b>Treble Speaker Unit</b>	510-3	Bearing grommet
203-1	Fibre spacer ring	510-4	Ball bearing
104	<b>Treble Rotor Belt</b>	510-5	Bearing clamp, lower half
507	<b>Treble Rotor Idler Pulley Assembly</b>	510-6	Metal bushing (2 used)
507-2	Pulley wheel	506-4	Rubber grommet (2 used)
507-3	Spring	511-2	Lower support mounting plate
507-4	Metal bushing	512	<b>Adjustable Mounting Plate, Lower Motor</b>
510-3	Rubber grommet	528	<b>Dividing Network, Complete</b>
506-2	Wing nut		<b>MISCELLANEOUS PARTS</b>
505	<b>Three Step Motor Pulley (Upper)</b>	526-19	Upper back cover
506	<b>Motor Assembly, Less Pulley</b> (Same assembly, upper and lower)	526-10	Plastic oil tube (state, "upper" or "lower")
506-2	Wing nut (2 used)	526-21	Lower back cover
506-3	Metal shoulder bushing (2 used)	530	<b>Bottle, Lubricating Oil</b>
506-4	Rubber grommet (2 used)		<b>MISCELLANEOUS SCREWS</b>
506-5	Bracket (2 used)	Thread and length	Quantity and where used
506-6	Pulley support wire ring	Parker Kalon	
506-7	Motor only	Self Tap	(2) Hold plastic case bottom cover
506-8	Oiling tube	6/32 x 1 1/8"	(3) Fasten 502-7 to 203
		6/32 x 5/8"	(2) Fasten 508-1 to 508-4
		8/32 x 5/8"	(4) Fasten bearing clamps to supports

10/24 x $\frac{3}{8}$ "	(2) Fasten bass rotor lower support
10/24 x $\frac{5}{16}$ "	(1) Fastens amplifier to cabinet
10/24x $\frac{7}{8}$ "	(1) In slot of 512 (place in 506-2 wing nut)
10/24 x $1\frac{1}{4}$ "	(8) Fasten 523 to shelf
10/24 x $1\frac{1}{2}$ " (black)	(12) Fasten backs to cabinet
10/24 x $1\frac{3}{4}$ "	(3) Fasten 203 to shelf
10/32 x 1"	(4) Fasten 525-5 strips to amplifier
#10 x $\frac{3}{8}$ " sheet metal	(2) Fasten 512 to shelf
10/24 "T" nuts	Used throughout cabinet construction
#8 x $\frac{7}{8}$ " sheet metal	Parts asembly
#6 x $\frac{1}{2}$ " wood screws	Control cases to console
10/24x $2\frac{3}{8}$ "	(2) Fasten 528 to shelf.





















**LESLIE®**

**ORGAN SPEAKER**

"PIPE VOICE OF THE ELECTRIC ORGAN"

**MODEL 22H**

**SERIAL 23906**

117 VOLTS 60 CYCLES 190 WATTS 2.1 AMPS

**ELECTRO**  **MUSIC**

PASADENA, CALIF.

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